MODIFIED MODEL OF MAGNESIUM PARTICLE IGNITION

K. A. Avdeev, F. S. Frolov, A. A. Borisov, and S. M. Frolov

N. N. Semenov Institute of Chemical Physics
Russian Academy of Sciences
Moscow, Russia

Ignition and combustion of solid particles are the issues of interest for many industrial and aerospace applications. When simulating ignition and combustion of solid particles using available standard models, a number of simplifying assumptions are usually adopted, which are not always justified. For example, for calculating heat flux to particle surface, the Newton law is often applied with the driving factor represented by the difference between the gas temperature and the mean particle temperature. However, the Newton law is known to be valid only for steady-state heat transfer. Moreover, the actual heat flux is determined by the particle surface temperature rather than the mean particle temperature. The objective of this work was to develop a new ignition model of magnesium (Mg) particles with the correction factors to the Newton law taking into account transient heat transfer of a particle with the ambient gas and nonuniform temperature distribution inside the particle. To determine the kinetic parameters of the overall surface reaction, the new particle ignition model was fitted to available experimental data on the Mg-particle ignition temperature. As a result, the preexponential factor in the Arrhenius-type expression of the reaction rate was shown to differ by the order of magnitude from that obtained based on the standard model. Thus, the transient heating effects were shown to be important for the problem of solid particle ignition in the oxidizer gas.